

BIOLOGICAL CONTROL OF THE COFFEE BERRY BORER

END OF PROJECT REPORT 1999-2002

*A publication of
The Caribbean Agricultural Research and Development
Institute (CARDI)*

*On behalf of
The Coffee Industry Board (CIB)*





END-OF-PROJECT REPORT

(MAY 1999 - APRIL 2002)

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EXECUTIVE SUMMARY

INTRODUCTION

The Coffee Industry Board (CIB) contracted the Caribbean Agricultural Research and Development Institute (CARDI) in May 1999 to implement a biological control project for the coffee berry borer (CBB), *Hypothenemus hampei* Ferrari, in Jamaica. The objectives of the project were to:

- (i) develop a protocol for mass rearing of introduced parasitoids and entomopathogenic fungi for managing coffee berry borer (CBB) infestations
- (ii) release the laboratory-reared parasitoids and entomopathogenic fungi and monitor their establishment in the field
- (iii) determine the potential of parasitic wasps and entomopathogenic fungi to reduce coffee berry borer infestations in selected areas in Jamaica over a three-year period
- (iv) train CIB extension officers in releasing and monitoring the above-mentioned biological control agents in the field.

INTRODUCTION AND MASS REARING OF THE PARASITIDS

The project launch was marked by a visit from PROMECAFE collaborators who brought initial cultures of the parasitoids, *Cephalonomia stephanoderis* and *Prorops nasuta*, which prey on and parasitise immature stages of the CBB. During the three years of the project, more than 550,000 *C. stephanoderis* were produced. Berries of *Coffea arabica* var. *typica* and *C. liberica* and coffee beans (parchment) were used in the rearing process in Year II; *C. liberica* berries had to be sourced because of the shortage of suitably CBB-infested *C. arabica* berries.

The mass rearing of *P. nasuta* was not as successful as that of *C. stephanoderis*; production of this parasitoid declined from 839 to 12 adults after only 8 generations. The mass rearing of this parasitoid was not continued further during the rest of the project. Since the project involved the

rearing of three biocontrol agents, investigations were made into the rearing of *Phymastichus coffea*, a parasitoid of the adult CBB, to replace *P. nasuta* in the project. Cultures of *P. coffea* were first imported into Jamaica from Honduras in April 2001, from which more than 1,300 *P. coffea* were produced in Year III during the first quarter. By the end of the third year, more than 7,300 adults were produced.

During the end of the first quarter of Year III, the rearing facility was contaminated by the fungus *Aspergillus* sp. This necessitated certain remedial measures to be made to the facilities to stave off future infections of cultures. Since all cultures were infected, new cultures of both *C. stephanoderis* and *P. coffea* were again imported from Guatemala in March 2002.

MASS REARING OF THE HOST

Seasonal variations led to the unavailability of the CBB from field-collected berries during Year I, which highlighted the need for the laboratory rearing of the CBB, the host of the parasitoids. This activity was, therefore, initiated in March 2001 and the CBB collected were used to establish CBB cultures (on parchment) and parasitoid cultures. Between March 2001 and April 2002, more than 1.1 million adult CBB had been collected from berries. The production of the host at the beginning was relatively high but subsequently declined in Year III when all the cultures were severely infected with *Aspergillus* sp., a fungus that resulted in decreased vigour of the CBB and their eventual mortality. Measures, such as enforcing proper laboratory practices that would reduce or prevent contamination of CBB and parasitoid cultures with *Aspergillus* sp. and close monitoring of cultures for signs of the fungus, were taken to ensure that the fungus would be kept under control and not have such a devastating effect on the cultures in the future. Rearing of the CBB in berries and parchment began once more in December 2001 in preparation for the re-importation of *C. stephanoderis* and *P. coffea* in early March 2002.

RELEASE, MONITORING OF ESTABLISHMENT AND EFFICACY OF *CEPHALONOMIA STEPHANODERIS*

Eight (release and control) plots, located at Rose Hill in St Andrew, Mountain Hill in St Catherine and Greenock in St Ann, were selected and baseline data collected from each site on agroecology, pest complex (and the CBB, in particular) and pest management and production practices. Though differences were observed in the pest composition and incidence at each

location, the CBB and coffee leaf miner were the major insect pests while leaf spot, coffee leaf rust and anthracnose were the major diseases. Infestation by the CBB ranged from 2 to 99% at the release and control plots. Natural enemies, such as ladybird beetles, spiders, ants and the entomopathogenic fungus, *Beauveria* sp., were observed across sites; incidence ranged from 3-60% when present.

Adult *C. stephanoderis* were first released at Rose Hill 2 (37,800 adults), Mountain Hill (5,000 adults) and Greenock (10,000 adults) during March-April 2000, and at Rose Hill1 (9,534 adults) in April 2001. Observations on the CBB populations in the release plots revealed that there was a decline (in CBB populations) compared to the control plots one to three months after the release of these parasitoids. This implied that there was successful parasitism of the CBB by *C. stephanoderis*, which was substantiated by the emergence of parasitoids from berries collected from release plots just one month after their release. Parasitoids were observed to have emerged from berries collected from release plots up to ten months after the release, indicating that the parasitoids had adapted to ambient Jamaican environmental conditions and the host life cycle under these conditions. The emergence of adult parasitoids from a plot 200 m from the release plot at Rose Hill 2 was observed for the first time ten months after the parasitoid release. This suggested that the parasitoid was able to disperse some distance (at least 200 m) away from the point of release.

In October 2000, when harvesting of berries at the study sites began, only cherry ripe coffee berries that were not infested with CBB were picked from trees in the release plots. This helped to conserve the parasitoid population in the plots and ensured that those parasitoids that emerged during the harvest period would have had sufficient CBB developmental stages on which to feed and to oviposit. Subsequent field and laboratory observations revealed that this method of selective harvesting yielded the desired results as substantial numbers of parasitoids (>4,700 from Mountain Hill and 400 from Greenock) were recovered from berries that had been stripped from trees at the end of the harvest period in March-April 2001.

The mean coffee yield obtained from the release plots at Mountain Hill and Greenock was higher than that from the control (no release) plots. This suggested that, given the external factors

present (such as climate, presence of host), one release of *C. stephanoderis* resulted in adequate parasitism of the CBB to effect a higher yield than if no parasitoids had been released. Hence, the parasitoid at the release sites did have a positive impact on the CBB management.

The efficacy of *C. stephanoderis* in reducing CBB populations and the establishment of *P. coffea* in the field could not be determined by the end of the project because of insufficient numbers of the parasitoids for releases and low infestation of berries by CBB in the field.

PRODUCTION OF OPERATIONS MANUAL

A framework for an operations manual to be used in training extension officers and technicians in the mass rearing of the parasitoids was produced in the first year of the project. Experiences garnered during subsequent years of the project were used to continually revise and improve the manual, which accompanies this report.

TRAINING OF FARMERS AND EXTENSION OFFICERS

More than 110 farmers and Extension Officers (from CIB and RADA) were trained under the project. The training was carried out at three levels, each of which targeted different groups within the coffee industry. In the Level I workshops - which were held in the parishes of St Andrew, Manchester, St James and St Catherine - a total of 80 coffee farmers, extension officers and other Ministry of Agriculture personnel attended, while 41 extensionists, farmers and farm workers attended Level II training sessions in St Catherine, Clarendon, St Catherine, Portland and St Andrew. Five persons selected by the CIB underwent three-week training sessions on the practical rearing of the parasitoids and CBB. These persons will be responsible for operating the rural rearing facilities and training other personnel employed by these facilities when the programme is adopted on a national level. Although the overall impact of this training cannot yet be realised, it is evident that it has sparked great enthusiasm and positive response from the participants of the training sessions, who are now aware of the many benefits of biocontrol.

MEETINGS

A Project Advisory Committee (PAC), comprising representatives from IICA, CIB, RADA, the Research and Development Division of the Ministry of Agriculture, the coffee farming

community and CARDI, was formed and held seven meetings over the three-year period. This committee was updated on the progress of the project and advised the project management on strategic issues. A Technical Advisory Committee (TAC) was also commissioned and consisted of members from PROMECAFE, CIB and CARDI; the TAC met twice in Jamaica to discuss the results of the project and made recommendations pertaining to the technical aspect of the project.

A review of the project, to assess its achievements and progress in accomplishing its stated objectives, and to inform on the way forward for Year III, was commissioned at the end of the second year of the project. Recommendations were made by the Review Team, some of which had already been implemented before the end of the review process.

During the second half of Year III, a proposal for the extension of the project for a further two years was submitted by CARDI to the CIB and discussions were underway to revise the proposal, which was being looked on favourably by the CIB.

GENERAL CONCLUSIONS

Over the three-year period, three of the four objectives of the project were met. The protocol for the mass rearing of *C. stephanoderis* has been developed, in addition to the protocol for mass rearing of the CBB and *P. coffea*, which was included in lieu of *P. nasuta*, with which limited success was achieved in the laboratory. It is envisaged that the inclusion in the project of *P. coffea*, an endoparasitoid of the adult CBB, will complement *C. stephanoderis*, an exoparasitoid and predator of the larval/pupal CBB, resulting in a more efficient management of the CBB.

The release and establishment of *C. stephanoderis* in the field was successfully determined at the four study sites. The training aspect of the project surpassed the objective of training CIB extension officers in releasing and monitoring the biological control agents in the field, as farmers and extension officers from CIB and RADA were also trained in the mass rearing procedure.

The potential of the parasitoids to reduce coffee berry borer infestations at the selected study sites was the only objective that was not achieved during the three-year period. The proposed

extension of the contract for a further two years should ensure that this objective will be carried out, in addition to other activities not included in the original project, such as the

- (i) refinement of the protocol for mass rearing of *P. coffea*
- (ii) release and assessment of establishment of *P. coffea* at selected sites
- (iii) determination of the timing and frequency of releases of this parasitoid in the field based on the level of CBB infestation present
- (iv) evaluation of a demonstration plot in which different management strategies are implemented
- (v) production of a quick-reference manual on coffee insect pests and their management.

This project plays an important role in the coffee industry of Jamaica and it should be viewed as the first step in the biocontrol component of an integrated management programme of the CBB that should be eventually implemented throughout the island. This national programme would involve the establishment of rural rearing facilities (RRF) across the island, which has already been initiated by the CIB, where the production of the parasitoids can be carried out at a central facility and then distributed to farmers within the area. Having these RRFs up and running would also ensure that stocks of the parasitoids are housed in different areas so that, should the stock from one facility be depleted, it could be replaced by the stock from another RRF. In addition (and perhaps more importantly), the risk of total loss of the island's parasitoid stock due to pathogens, unavailability of host material, natural disasters, etc, would be minimised.

There is no doubt that the parasitoids can be successfully mass produced in RRFs in Jamaica and, once the cost of (i) establishing what may be termed an ideal facility and (ii) the mass production of parasitoids at such a facility is determined, modifications may be made to reduce the cost to suit the resources available for a particular area. In addition to having the RRFs, though, there should be a central rearing facility where a small parent stock of parasitoids is kept at optimal conditions and from which starting parasitoid stock can be obtained for any one of the RRFs. If such a system is implemented, such a biocontrol programme can be successful in Jamaica.

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1.0. HIGHLIGHTS

- The mass rearing of parasitoids of the CBB produced:
 - more than 550,000 *Cephalonomia stephanoderis* during the three-year project period
 - over 7,300 *P. coffea* during Year III of the project
- Rearing of the CBB - the host of the parasitoids – began at the end of Year II, and more than 1.1 million adults were collected
- The release of *C. stephanoderis* were carried out at three of the study sites at the end of Year I and at the fourth site at the end of Year II
 - 9,534 adults were released at Rose Hill 1 in the parish of St Andrew and 117 emerged from berry samples taken up to one year later
 - 37,800 adults were released at Rose Hill 2 in the parish of St Andrew
 - 10,000 adults were released at Greenock in the parish of St Ann and 565 emerged from berry samples taken up to one year later
 - 5,000 adults were released at Mountain Hill in the parish of St Catherine and > 4,705 emerged from berry samples taken up to one year later
- *C. stephanoderis* were recovered from these release sites one year after the single release
- Parasitoids were first observed in neighbouring plots at Rose Hill 2 in February 2001, ten months after the release
- The mean coffee yield was higher in the release plots at Mountain Hill and Greenock than in the control plots, suggesting that the parasitoid releases at these sites did have a positive impact on the CBB management
- A manual was produced on the mass rearing procedure for the parasitoids and the CBB
- At Level I and II workshops held during Years II and III, approximately 110 farmers, farm workers and Extension Officers were trained under the project